THE STATUS OF THE VERY RARE *PRUNUS GRAVESII* SMALL

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In 1897, J.K. Small described a new species of *Prunus*, naming it in honor of Dr. Charles B. Graves, a Connecticut physician and amateur botanist. Graves discovered this plum on an esker (today known as Esker Point) along the Connecticut shore of Long Island Sound in the town of Groton. Numerous herbarium specimens (Arnold Arboretum, A; University of Connecticut, CONN; Gray Herbarium, GH; and New England Botanical Club, NEBC) the earliest of which I have seen was dated 25 Sept. 1894 (A), were taken of this plant in the years immediately following its description.

Prunus Gravesii has received almost no attention in the intervening 82 years since its description. In spite of intensive collecting throughout coastal New England and the New York City-New Jersey area, no other stations for *P. Gravesii* have been found. The stand of *P. Gravesii* at the type locality occupies roughly 60 m^2. There are more than 30 large ($>$ 3 cm in diameter) healthy stems reaching a maximum height of about 2.5 m. There are also several young stems around the edges of the stand. The growth form of the Graves Beach Plum looks much like the vegetatively propagated colonies of its closest relative, *P. maritima* Marsh., the Beach Plum. The latter forms colonies by producing shoots from underground runners (roots). Excavations of parts of the *P. Gravesii* stand showed organic connection between the upright stems.

The logical conclusion from this is that *Prunus Gravesii* is indeed very rare; indeed it is represented by a single, relatively large, multistemmed individual. According to a note on a herbarium specimen collected by Graves in 1899 (8 Sept., in GH), "This type locality was burned over several years ago, leaving only a few mature shrubs. There are plenty of sprouts but they do *not* flower or fruit." *Prunus Gravesii* thus apparently was, and continues to be, a single vigorous plant.

Rare objects and organisms are of interest for several reasons (Stebbins, 1942; Drury, 1974; see this symposium). In this instance, the question of the nature of origin of the species (*Prunus Gravesii*) is of particular interest, because there is presently only the single, presumably long-persisting, individual. Three questions were formulated which provided the structure upon which the work described below was based. The questions are.

Is *P. Gravesii*—
a) a distinct, but relict species?
b) an interspecific hybrid?
c) a mutant derivative of *P. maritima*?

MATERIALS AND METHODS

Morphology—A total of 38 features were measured, scored, or calculated for *Prunus Gravesii* and *P. maritima*. These features were derived from 10–15 samples of the *P. Gravesii* plant (the mean values were used in statistical tests), and from 40–60 individuals of *P. maritima*. The latter were collected along the coasts of New Hampshire, Massachusetts, and Connecticut. The small stand of *P. maritima* growing adjacent to *P. Gravesii*, and greenhouse-grown seedlings of both *P. maritima* and *P. Gravesii*, were treated as distinct samples for some analyses. See Appendix A for specimen citation. Representative specimens have been deposited in GH. Other specimens are in the author's collection or CONN.

A t-test modified for comparison of a single specimen (*P. Gravesii*) with a sample population (*P. maritima*) was used to test for significant differences (see Simpson et al., 1960, for the test).

Fertility—Pollen viability was estimated by staining grains with aniline blue in lactophenol (Hauser & Morrison, 1964). Seed germination was tested using a method modified from the U.S.D.A. "Seeds of Woody Plants in the U.S." (1974). The fleshy exocarp and mesocarp were removed from the fruits, the endocarps dried for a few days, and then planted about 1 cm deep in flats containing a mixture of 1 part sand: 1 part peat. The seeds were stratified as follows: 14 days in sunlight in the greenhouse, and 160 days in a dark cold room (120 days was less satisfactory). Flats were then moved back to the greenhouse. Germination usually followed in 4–6 weeks.

Crosses and pollination tests—Hand pollinations to test self- and inter-compatibility were made on flowers which had been enclosed in paper bags (glassine envelopes or Carpenter Paper Co. "Pollen-Tectors") as unopened flower buds. Such bags were also used to enclose flowers to test for automatic self-compatibility and apomixis. Tests for the effectiveness of wind pollination were made by enclosing unopened buds in screen-mesh bags with a pore size of 1.2

mm, i.e., large enough to allow the pollen (35–40 μm diameter) to pass through, but small enough to exclude virtually all potential pollinators. Open pollination was tested simply by counting and marking a large number of unopened buds. For all the above tests, fruit set was counted in late August or early September. More ovaries began enlarging (early June) than developed into full-sized fruits.

Chromosome analyses—Both mitotic and meiotic divisional figures proved difficult to find. The time of division especially for pollen mother cell meiosis is very critical. Cells divide for only a short period of time about 3 weeks prior (late April 1979) to flowering. Branchlets were fixed in Carnoy's or Newcomer's solutions and stained with aceto-orcein.

Staining proved very difficult for mitotic studies. The most successful technique involved fixing root tips as above, followed by staining first with Schiff's reagent (following hydrolysis in dilute HCl) and then with 1:1 aceto-orcein and 1 N HCl.

Chromatography—Flavonoids were extracted in 80% methanol from dried leaves of the five species listed below. Two dimensional chromatograms utilizing butanol- acetic acid -water (6-1-2) and acetic acid (5%) were used for separation. The chromatograms were viewed under ultra-violet light, and the positions of spots in the presence and absence of ammonia were recorded. In addition to *Prunus Gravesii* and *P. maritima*, three other species were run for comparison. Two of these (*P. angustifolia* and *P. alleghaniensis*) are morphologically similar to *P. Gravesii* and *P. maritima*, and the third (*P. serotina*) was included as a representative of another subgenus.

RESULTS

Phenology—Although Small (1897) reported that *Prunus Gravesii* preceeded *P. maritima* in some phenological features, in five seasons' observations, I have found the opposite to be true of leaf emergence and flowering. Exact flowering time depends on the season, but, in general, *P. Gravesii* begins flowering 1–2 weeks after *P. maritima*; thus *P. Gravesii* usually flowers in mid to late May. Although *P. maritima* is well past its peak in flowering (in Connecticut) by the time *P. Gravesii* begins, the two flowering periods do overlap. Furthermore, some individuals of *P. maritima* reach their maximum flowering later than the average. E. H. Eames noted such plants at Milford Point, Milford, Ct., which are "about 2 weeks later than abundant normal plants as seen here and elsewhere" (*Eames 11945*, CONN); I have noted the same phenomenon (and perhaps the same plants) at this locality.

Morphology—Only four of the 38 characters assayed differ significantly ($P \leq 0.05$) between *Prunus maritima* and *P. Gravesii*. These characters (style length, "seed" size-actually endocarp size, leaf length, leaf length/width ratio) are shown in Fig. I (A–D). The mean values of several other features of the two taxa differ but not significantly. Even for the 4 significantly different characters the standard deviations of *P. Gravesii* in some instances, and the ranges in all instances, overlap those of *P. maritima*. It is of interest to note that for some of the features, the values for *P. Gravesii* seedlings (PG_S) and *P. maritima* Esker Point (PM_E) are intermediate between those of *P. Gravesii* (PG) and typical *P. maritima* (PM) (e.g., leaf length), and for others, the PG_S and PM_E values are very similar to those of *P. maritima* (e.g., style length, leaf length/width ratio).

The scatter diagram shown in Fig. II couples one significantly different feature with two others which show differences (though not significnt differences) between the two taxa. THis figure has several notable features. First, the *P. Gravesii* points (PG) are quite distinct from the other points. This is in striking contrast to the seedlings of *P. Gravesii* (PG_S). The three which flowered fall within the center of distribution of typical *P. maritima*; *P. Gravesii* does not breed true for any of the characters examined. *Prunus maritima* from Esker Point (PM_E), as expected, also scattered throughout the PM points. Also the range of variation for *P. maritima*, which is derived from several genetically independent indidivuals, is much broader than that of *P. Gravesii*.

Pollen fertility—*Prunus Gravesii* exhibits a degree of pollen stainability which is on the average as high as or higher than that of *P. maritima* (Fig. III). The range of stainability for *P. Gravesii* is greater than for any other group tested, but the mean and standard deviation are reasonably close to those of the other groups tested. In fact, the few greenhouse-grown seedlings of *P. Gravesii* (PG_S) showed a significantly higher stainability than the seedlings of *P. maritima* (PM_S). The *P. maritima* growing in the vicinity of *P. Gravesii* (PM_E) manifested the highest stainability of any of the groups tested.

Seed fertility—The data in Table 1 indicate that both *Prunus Gravesii* and *P. maritima* show relatively high seed germination in

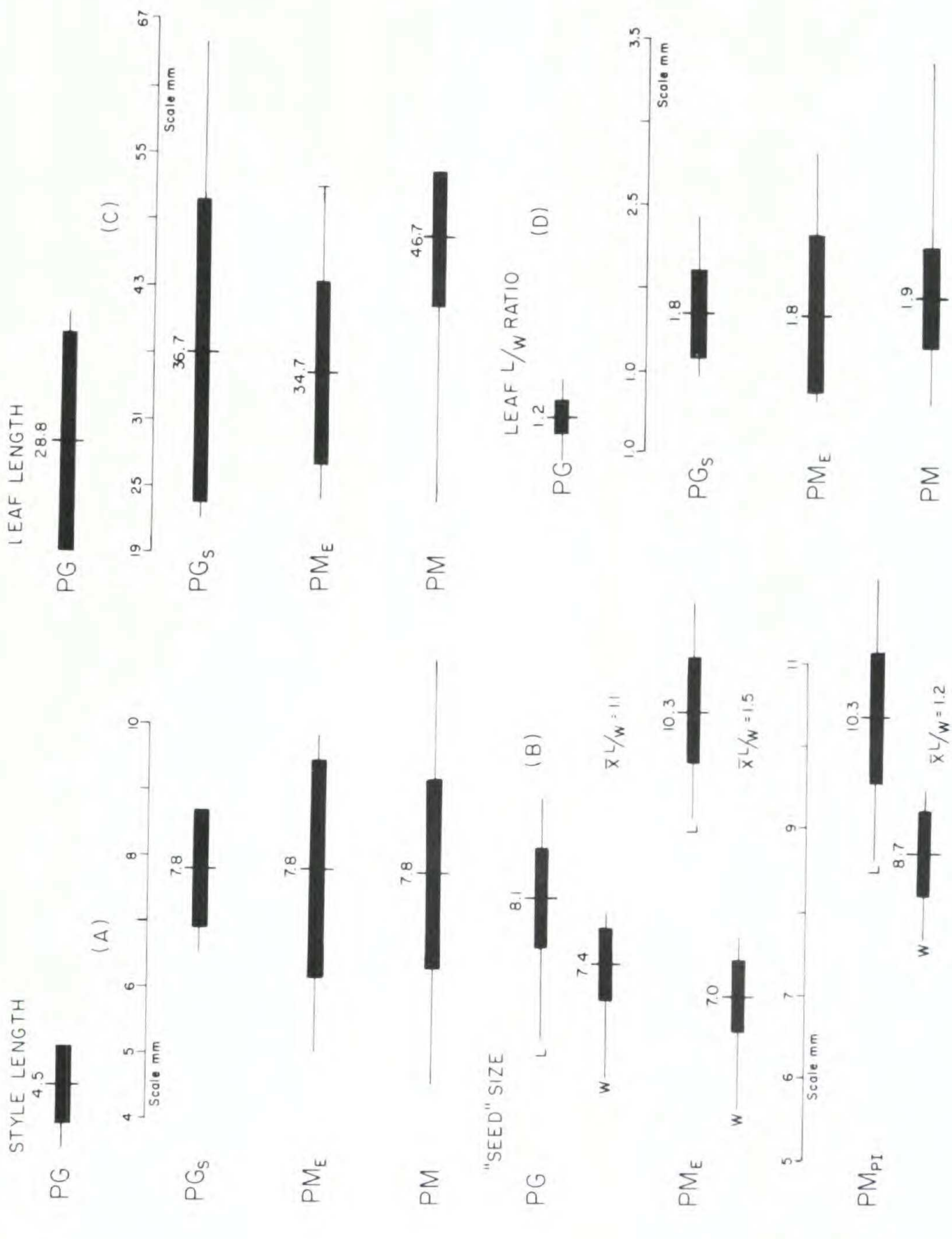

Figure 1. Statistically significant morphological differences between *P. Gravesii* and *P. maritima*. PG-*P. Gravesii*, PG_S-greenhouse-grown seedlings of *P. Gravesii*, PM-*P. maritima*, PM_E-*P. maritima* from Esker Point, Ct., PM_{PI}-*P. maritima* from Plum Island, Mass. For all 4 features (A–D), the following are given: mean (vertical line and number), range (thin horizontal line), and standard deviation (broad horizontal line).

the first year following planting. As mentioned above, the seedlings of *P. Gravesii* (PG_S) are morphologically similar to *P. maritima*, and not to *P. Gravesii*. Such morphology has been maintained by two- and three-year old seedlings as well.

Breeding system and crossability—Both *P. Gravesii* and *P. maritima* are protogynous. Frequently the styles and expanded stigmas of *P. maritima* are long-exserted from unopened buds. In some *P. maritima*, and in *P. Gravesii*, the styles are not exserted from the bud, but the stigmas appear fully expanded and receptive before the

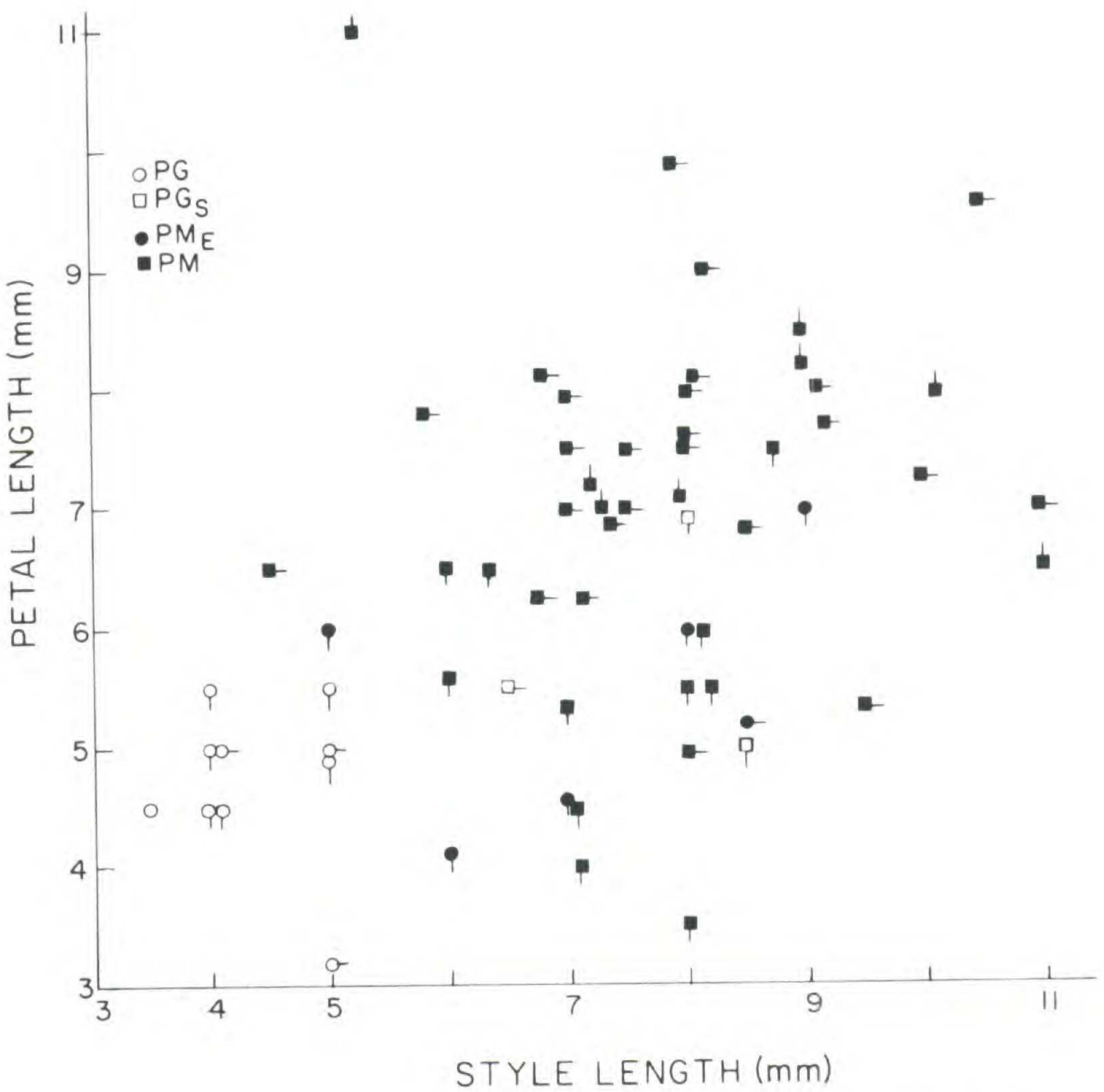

Figure II. Scatter diagram of selected floral features. The abbreviations with the symbols are the same as for Fig. I. The whisker represents sepal length; ⚲ 2.0 mm or less, O-2.1–3.0 mm, ♁ 3.1 mm or more. The PG points represent different flowers from the same plant; all other points represent different individuals.

anthers dehisce. The flowers of both *P. maritima* and *P. Gravesii* are of the "dish-bowl" type and bear nectar at the base of the hypanthium. As a result of their generalized shape, flowers are visited by, and pollination is apparently accomplished by, a range of insects including honey bees, native bumble bees, and other small bees. Ants and non-hymenopterans have also been seen in the flowers.

Efficiency of pollintion and fruit set have been tested over a period of three years. The results of these studies are given in table 2. Several features are noteworthy:

1) Fruit set per flower is very low in both *P. maritima* and *P. Gravesii;* it falls below 1% in all cases (see "controls") except where artificial hand-pollinations were involved.
2) Both *P. Gravesii* and *P. maritima* are self-incompatible. Except for the single fruit set for *P. Gravesii* (1976) which on planting did not germinate, none of more than 900 flowers that were self-pollinated by hand resulted in fruit set. Furthermore, none of the nearly 2500 additional flowers enclosed in paper bags resulted in fruit. These also represent in part a test of self-incompatibility because over 25% of the *P. maritima* flowers and over 50% of the *P. Gravesii* flowers possess styles which bend back to the anthers in such a way that at least some of them are self-pollinated.
3) The lack of fruit set by either *P. Gravesii* or *P. maritima* flowers covered by screen bags seems good evidence that neither species is anemophilous.
4) In *P. maritima*, hand pollinations between individuals ("sisters") yielded a large increase in fruit set over controls. One of the resulting seeds germinated.
5) Crosses made between PM×PG with *P. Gravesii* as the pollen parent were also successful. Although the resultant seeds were full-sized, none have yet germinated. Although no "sister" crosses could be performed with *P. Gravesii* (there is only the single individual), a single cross with a *P. maritima* pollen parent (and *P. Gravesii* as the female) was successful. However, the resulting seed did not germinate.

Chromosome number and behavior—Counts of chromosomes in mitosis indicated that *Prunus Gravesii* is a diploid with $2n = 16$. This is the same chromosome number as reported for *P. maritima*

(Sax, 1931), and for the majority of *Prunus* species (Federov, 1969). The chromosome number was also verified in analysis of pollen mother cell meiosis. In addition, as expected based on the relatively high fertility estimates (pollen stainability), no gross abnormalities of structure or pairing were detected in meiotic cells.

Chromatography—The chromotograms (Fig. IV) show *P. Gravesii* to be identical with *P. maritima;* all compounds are shared, with two not found in any of the other 3 species tested. Surprisingly, *P. angustifolia* is more similar to *P. serotina* (85% of the compounds are shared) than it is to either *P. maritima - Gravesii* or to *P. alleghaniensis* (about 30% of the compounds shared). As pointed out above, the latter three species and *P. angustifolia* are morphologically similar. *Prunus alleghaniensis* has more spots in common (about 50%) with *P. angustifolia - serotina* than it does with *P. maritima - Gravesii* (about 30% shared).

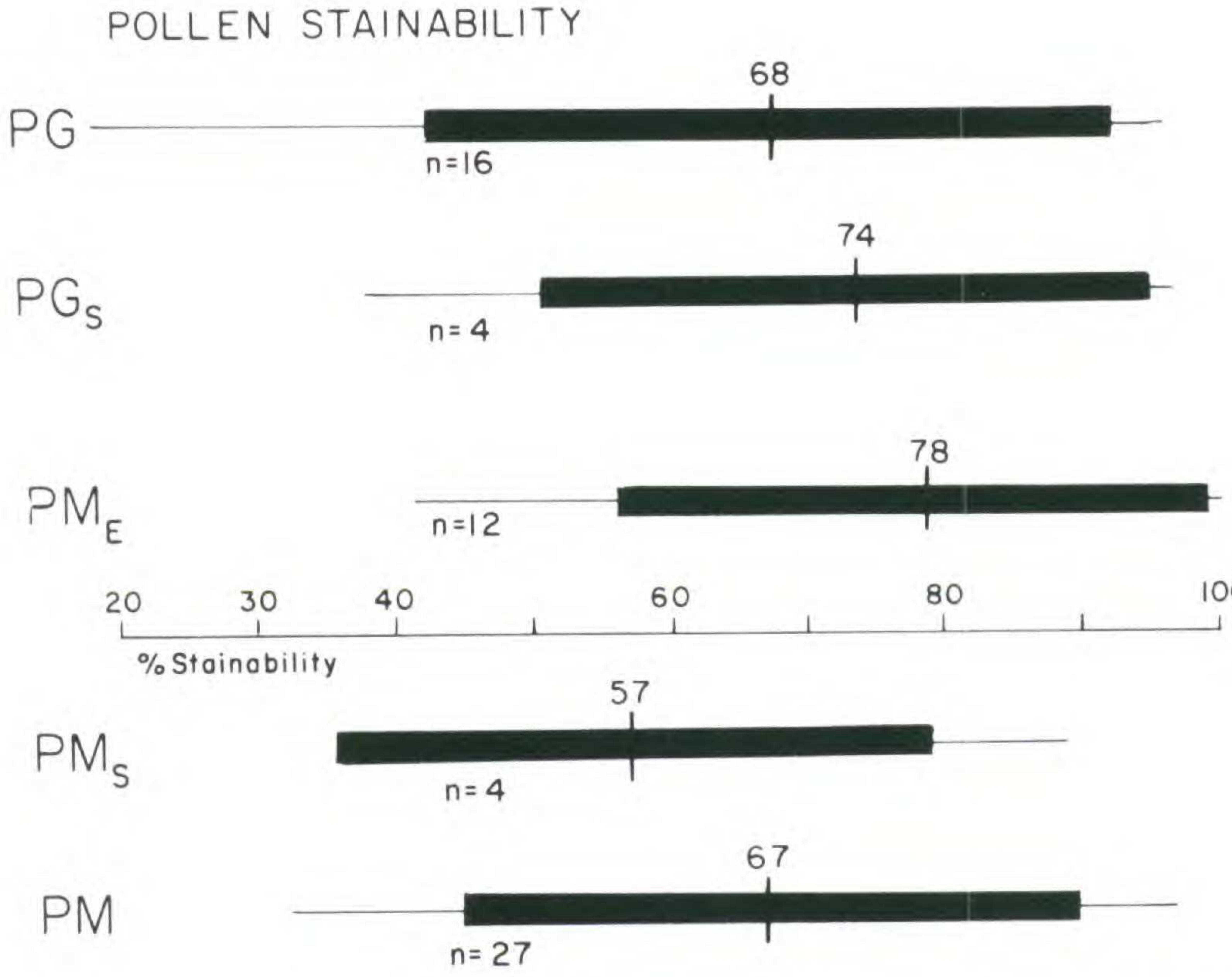

Figure III. Pollen stainability. The lines and bars represent means, ranges and standard deviations (as in Fig. I) of the percent stainability. PM_S-greenhouse-grown seedlings of *P. maritima*. The sample sizes are for different individuals except for PG where the sample is of different flowers from the same individual.

The colors of the compounds under ultra-violet light in the presence and absence of ammonia are given in Appendix B.

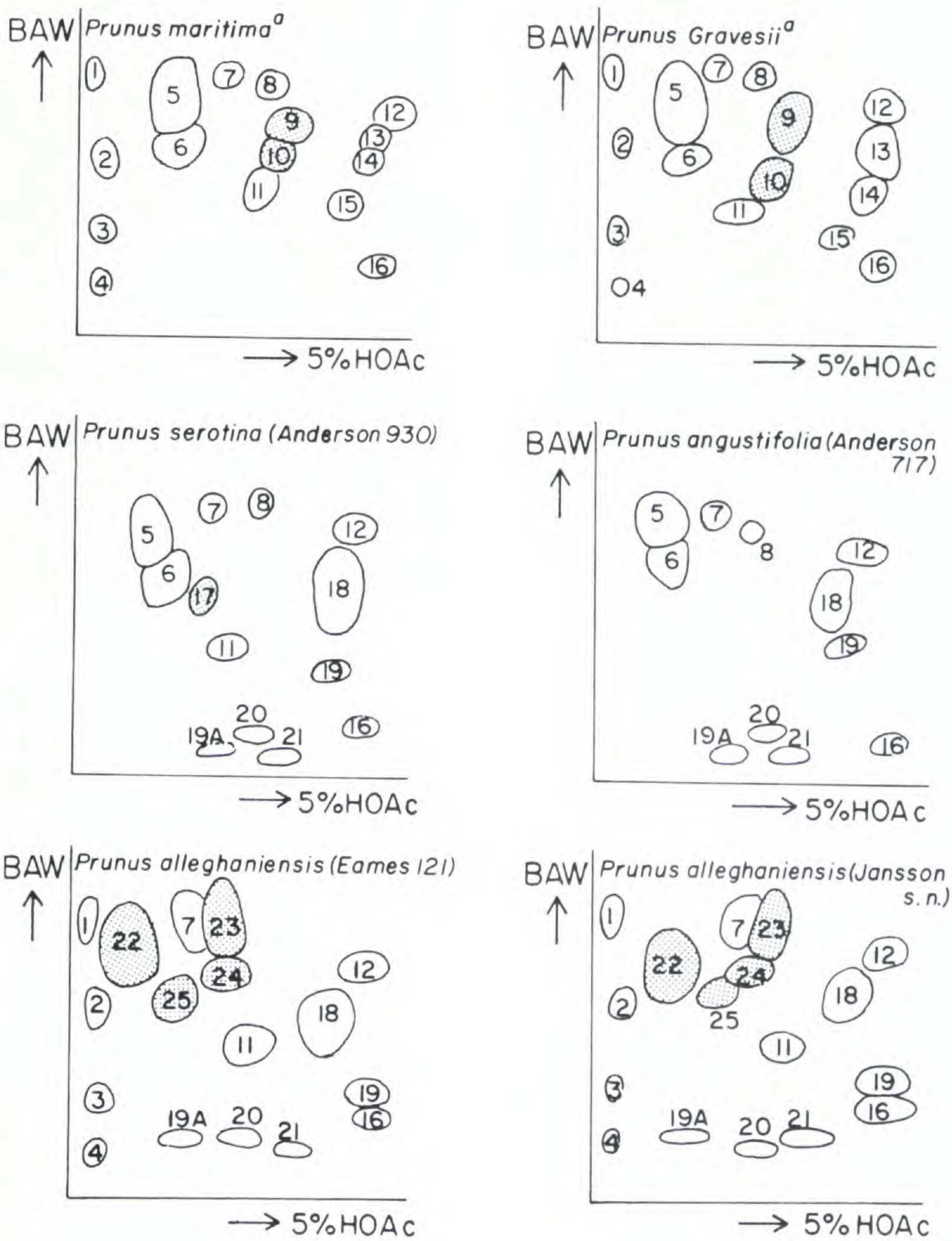

Figure IV. Chromatographs. BAW-butanol-acetic acid-water (6–1–2), HOAc-acetic acid. Spots with stippling are unique to the species (or species groups) given. a- numerous specimens were tested for each of these species.

DISCUSSION AND CONCLUSIONS

It is perhaps most appropriate here to return to the 3 questions posed in the introduction.

a) Is *Prunus Gravesii* a distinct, but relict species?

Certainly *P. Gravesii* has a sufficient array of morphological distinctions to justify its recognition as a separate species. Some taxa in other groups are distinguished by fewer differences. Furthermore, *P. Gravesii* is both pollen and seed fertile. However, intensive collecting has never yielded any other individuals of *P. Gravesii* than the one in Connecticut, and for whatever reason (see below) *P. Gravesii* does not breed true. The *P. Gravesii* plant has been growing vigorously in the same place for more than 85 years (Graves' first known collection is 1894) without leaving any recognizable offspring. Thus, although *P. Gravesii* is morphologically distinguishable, it is represented by one individual and has not achieved any means by which to reproduce itself. Given these factors, *P. Gravesii* can hardly be recognized as a distinct species.

The next two possibilities are best considered together because the same data are appropriate for distinguishing between them.

b) Is *P. Gravesii* of hybrid origin?

c) Is *P. Gravesii* simply a mutant derivative of *P. maritima*?

Prunus Gravesii undeniably appears to be quite distinct from *P. maritima*, but when the distinctions between them are critically analyzed, there are few which "hold up". Small (1897) cited 6 differences (several of which were provided by Graves, since Small apparently did not see the living plant) betwen *P. Gravesii* and *P. maritima*. These differences together with comments are given below.

1.a) "maximum height of about 12 decimeters" as compared with *P. maritima*, which is up to 2.5m high—perhaps in the late 1800's, but today the plants are nearly twice that size.

b) *Prunus Gravesii* plants are lower and more delicate and the leaves and fruits mature earlier than *P. maritima*. The first part of the statement is not true of *P. Gravesii* today, and, although I am not sure about fruit maturity, 5 years of observations confirm that *P. Gravesii* leafs out, and flowers later than *P. maritima*.

2. *Prunus Gravesii* has a "small orbicular type of leaf"—this remains the best feature for distinguishing the two taxa.

3. *Prunus Gravesii* has "smaller flowers with suborbicular petals" which are "abruptly narrowed at the base". The flowers of *P. Grave-*

Table 1. Seed germination.

SEED GERMINATION

YEAR	*P. Gravesii*		*P. maritima*	
	PLANTED	GERMINATED	PLANTED	GERMINATED
1978-79	136	35	330	96
1977-78	138	80	312	112
1976-77	47	19	925	508
1975-76	22	3	457	80
TOTALS	343	137	2024	796
%GERMINATION	39.9%		39.3%	

sii do have a lower mean size than those of *P. maritima*, but the sizes are not significantly different, nor are the petal bases of *P. Gravesii* much different from those of *P. maritima.*

4. *Prunus Grvesii* has a "small very turgid stone". The *P. Gravesii* endocarps assayed in this study were significantly smaller than those of *P. maritima*, but did not differ in length/width ratio.

5. *Prunus Gravesii* has a "smaller, always globose, short pedicelled drupe". I did not measure exocarp size or fruiting pedicel length. However, flowering pedicels of *P. Gravesii*, although shorter on the average, are not significantly shorter than those of *P. maritima.*

6. *Prunus Gravesii* "Sprouts arising from the ground never produce flowers". I am not sure of either the validity or value of this distinction.

Thus, only 2 (possibly three if drupe length follows endocarp length) features from the above list serve to distinguish *Prunus Gravesii* from *P. maritima*. Additionally, I found 2 other characters which show statistically significant differences: leaf length (a manifestation of shape) and style length. Given that chromosome number, habit, habitat, and leaf flavonoids also are not different, the two taxa can be recognized by only the above 4 features. Furthermore, in all of these 4 features the range of *P. maritima* overlaps

Table 2. Fruit set. a. self-pollinations, b. buds enclosed in pollen-proof bags, c. buds enclosed in screen bags, d. crosses between different individuals of the same species, e. crosses between the 2 species; crosses are listed with the species used as the female parent.

	FRUIT SET											
	⊗[a]		BAGGED[b]		WIND[c]		CONTROL		SISTERS[d]		PMxPG[e] PGxPM	
SPECIES	FLS	FRS	FLS	FRS	FLS	FRS	FLS	FRS	FLS	FRS	FLS	FRS
PM												
1978	134	0	953	0	1123	0	4737	16	27	2	72	3
1977	113	0	373	0	170	0	7439	81	1	0		
1976	197	0	117	0	112	0	473	1			111	0
TOTALS	444	0	1443	0	1293	0	12649	98	28	2	183	3
%							0.78%		7.14%		1.64%	
PG												
1978	135	0	682	0	396	0	1669	0			78	0
1977	57	0	89	0	40	0	2574	24			35	1
1976	276	1	252	0			859	0			137	0
TOTALS	468	1	1023	0	436	0	5102	24			250	1
%	0.21%						0.47%				0.4%	

by 1/3 to 2/3's that of the range of *P. Gravesii.* The only unequivocally distinctive feature of *P. Gravesii* is the shape of the leaves; no leaves of *P. maritima* are orbiculate with truncate apices. In light of these morphological data and of the relatively high seed and pollen fertility of *P. Gravesii,* it is not unreasonable to conclude that it originated by one or very few mutation(s) from *P. maritima.* The range of morphological variation of *P. maritima* clearly encompasses much of that of *P. Gravesii.* Further, as noted in the Phenology section, notable later flowering individuals of *P. maritima* (simultaneous with the peak of blooming of *P. Gravesii*) have been recorded. Thus, in total, the differences between the two taxa are such that *P. Gravesii* can be considered to have arisen by mutation from *P. maritima.*

On the other hand, many of these data would not be incongruous with the hypothesis that *Prunus Gravesii* is a hybrid. Such an origin cannot be ruled out with certainty. If *P. Gravesii* were self-compatible, or if there were two individuals, it would be possible to look at the segregation, or lack of it, in offspring for several characters and thus attain stronger evidence for or against a hybrid origin. It is theoretically possible to distinguish between the segregation ratios of: a) a backcrossing hybrid or, b) a mutant form crossing with a typical form. However, given the paucity of differences between the two taxa that one could follow, and the lack of any information on the genetic basis of characters in *P. maritima* (or *P. Gravesii*), it seems unlikely that such data even from large populations would enable one to reach a definite conclusion. However, for the following reasons, I am inclined to consider a hybrid origin to be less likely at this point:

a) *P. Gravesii* is as fertile as *P. maritima.*

b) *P. Gravesii* is chemically identical with *P. maritima.*

c) The distinctive morphological features of *P. Gravesii* are not clearly indicative of features of any other *Prunus* species in the northeast U.S. The species which have leaves that are more orbiculate (e.g., *P. mahaleb* or *P. armeniaca*) have other characteristics which do not appear in *P. Gravesii.*

The chemical data are most unequivocal. Not all interspecific hybrids are necessarily sterile, and transgressive variation might explain the development of fetures found in no other species, but, in many instances (e.g., Alston & Turner, 1963) chemical profiles have clarified the hybrid nature of plants or populations which were otherwise not detected. The fact that other related species of *Prunus* do have recognizably distinct flavonoids which are not present in *P. Gravesii,* and the fact that the latter is chemically identical with *P. maritima* make it even less likely that *P. Gravesii* originated through hybridization.

Conclusions—The acceptance of *Prunus Gravesii* as simply a mutant derivative of *P. maritima* allows for some interesting speculations. The self-incompatibility of *P. Gravesii* means that it must depend on *P. maritima* as a pollen source. This would explain why the morphology of *P. Gravesii* seedlings is more similar to that of *P. maritima* than it is to the female parent. The fact that *P. Gravesii* seeds germinate at a rate equal to that of *P. maritima,* and that the former has been growing for more than 80 years, suggests that offpsring should exist somewhere. Given the somewhat aberrant morphology of some of the *P. maritima* plants at Esker Point (PM_E), it seems reasonable to consider that they are *P. Gravesii* offspring. The mean values for several morphological features (e.g., leaf length, petal length, sepal length) of PG_S and PM_E are very similar and intermediate betwen those of typical *P. maritima* and *P. Gravesii.*

The entire individual of *P. Gravesii* is today, and apparently was when Graves studied it at the close of the 19th century, uniform throughout. That is, no stems of *P. maritima* type morphology grow close enough to be considered part of it. Thus, it would sem most likely that the mutation or mutations which gave rise to *P. Gravesii*: a) took place in a flower yielding the single *P. Gravesii* seed, or possibly b) some environmental extreme caused somatic mutations in a seedling of *P. maritima*. In either case, because the range of variation in *P. maritima* encompasses most of that found in *P. Gravesii* for most features, it is not necessary to postulate many mutations to yield *P. Gravesii*. If pleiotropic effects of genes are considered, perhaps several distinctive features of *P. Gravesii* (e.g., those dealing with different lengths) are attributable to a few or even a single gene.

If *P. Gravesii* can no longer be recognized as a species, should it be considered for protection? It does not fit into the usual categories for protection of endangered species; it is not a species. However, I would argue for its protection on the grounds that it is no less interesting now than prior to this work. In fact, recognition of its long persistence, and an understanding of its possible origin make it perhaps even more valuable to protect. Furthermore, *P. Gravesii* may exemplify the kind of event that occurs more commonly than expected in nature. Possibly some other rare species are likewise narrowly distributed mutant variants, or morphological, or physiological, or ecological extreme types of more well-established species. In *P. Gravesii,* and perhaps in some other rare taxa, distinctive attributes, sufficient to warrant recognition as a species are acquired, but isolating barriers have not developed in the process of speciation. In addition, a breeding system capable of perpetuating *P. Gravesii* is also lacking. The adaptive value of the distinctive morphological features of *P. Gravesii* has not been tested beyond the single individual bearing them. Thus, *P. Gravesii* is perhaps worthy of protection as a well-documented illustration of the kind of event which occurs more frequently in nature than is generally detected or recognized.

Prunus Gravesii will be formally recognized as a variety of *P. maritima* in a subsequent note.

SUMMARY

Prunus Gravesii is among the rarest species in the northeast U.S. It has been represented by a single, long-lived individual since its discovery. The plant from which the species was described by J.K. Small in 1897 still grows vigorously. *Prunus Gravesii* differs from its closest relative, *Prunus maritima*, by only 4 statistically significant morphological features. Both species have $2n = 16$ chromosomes, are intercompatible, and share a virtually identical array of leaf flavonoids. *Prunus Gravesii* is insect pollinated, self-incompatible, and is both pollen and seed fertile. However, seedlings of *P. Gravesii* resemble *P. maritima*. It is concluded that *P. Gravesii* is a mutant derivative of *P. maritima*, which depends on the latter as a pollen parent. *Prunus Gravesii* is best treated as a variety of *P. maritima*.

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APPENDIX A

The following are localities and representative collections from which population samples were taken.

Prunus alleghaniensis
Connecticut
Fairfield County: Bridgeport; *E.H. Eames 121.* (CONN).
New London County: Cultivated, Connecticut College Arboretum, New London; *K.P. Jansson s.n.*, 9 Sept. 1933, (CONN).

Prunus angustifolia
Connnecticut
New London County: Occum; *W. Linke s.n., Anderson 717* (CONN).

Prunus Gravesii
Connecticut
New London County: Esker Point, Groton: *Anderson 526, 562, 580, 621, 719.*

Prunus maritima
Connecticut
New London County: Esker Point, Groton; *Anderson 525, 563, 564, 581, 582, 720.*
Barn Island; *Anderson 561.*
Bluff Point, Groton; *Anderson 527, 622.*
Griswold Point, Old Lyme; *Anderson 525, 536, 537.*
New Haven County: Milford Point, Milford; *Anderson 528, 529, 530, 532.*
New Haven; *Anderson 534*
Massachusetts
Essex County: Parker River Wildlife Sanctuary, Plum Island; *Anderson 544–558, 586–588, 591–597.*
New Hampshire
Rockingham County: Seabrook Beach; *Anderson 598–611.*
Rhode Island
Washington County: Misquamicut; *Anderson 538, 539, 540, 620.*
Weekapaug; *Anderson 560.*

Prunus serotina
Connecticut
New London County: Esker Point, Groton; *Anderson 930.*

APPENDIX B

Color changes of chromatographic compounds under ultraviolet light following fuming with ammonia. 1. yellow→yellow. 2. yellow→yellow. 3. yellow→bright yellow. 4. yellow→no change. 5. dark mauve→bright yellow. 6. dark mauve→bright yellow. 7. pale blue→blue. 8 pale blue→pale mauve. 9 bright yellow→orange yellow. 10. bright yellow→orange yellow. 11. dark mauve→yellow green. 12. dark blue→bright blue. 13. bright blue→green blue. 14. green→bright green. 15. yellow→bright yellow. 16. mauve→bright mauve. 17. pale yellow→yellow. 18. pale blue→bright blue. 19. blue→blue. 19A. dark→yellow. 20. mauve→mauve. 21. dark→yellow. 22 blue-green→blue. 23. dark→yellow. 24 dark→yellow. 25. dark→yellow.